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Artículos científicos

Medición de la tercera misión en las universidades públicas estatales en México por medio del análisis envolvente de datos

Measurement of the Third Stream in the State Public Universities in Mexico, through the Data Envelopment Analysis

Medição da terceira missão em universidades públicas estaduais no México por meio de análise envoltória de dados

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Resumen

La tercera misión de las instituciones de educación superior busca generar y aplicar conocimiento que coadyuve al impulso del bienestar social a nivel regional, nacional e internacional. Para lograrlo, las IES deben ayudar a la construcción de proyectos innovadores (científicos y tecnológicos) que permitan desarrollar metodologías disciplinarias y multidisciplinarias que faciliten la resolución de los problemas reales que tiene la sociedad. A más de diez años de esta misión actual, es importante contar con un sistema de indicadores que ayuden a medir su eficiencia con la finalidad de conocer la situación que guardan las universidades públicas estatales (UPE) en México en relación con dicha misión. Por lo tanto, el objetivo de esta investigación es identificar el grado de avance de las dimensiones de emprendimiento, innovación y compromiso social mediante la medición de la eficiencia

técnica. Como hipótesis se plantea que la eficiencia de las UPE en México con respecto a su tercera misión es mayor a 70 %. Mediante la metodología de análisis envolvente de datos (DEA, por sus siglas en inglés), se obtuvieron los siguientes resultados: el promedio de eficiencia técnica con rendimiento variables a escala fue de 91.30 %. La dimensión de innovación fue la que obtuvo el mayor número de universidades con eficiencia, mientras que la dimensión de emprendimiento consiguió menos UPE eficientes. Lo anterior significa que las instituciones llevan a cabo actividades encaminadas al fomento de su tercera misión.

Palabras clave: análisis envolvente de datos, compromiso social, eficiencia, emprendimiento, innovación.

Abstract

The Third Stream of Higher Education Institutions (HEIs) seeks to generate and apply knowledge that contributes to the promotion of social welfare at the regional, national and international level. To achieve this, HEIs must help the construction of innovative projects (scientific and technological) that allow the development of disciplinary and multidisciplinary methodologies that facilitate the resolution of real problems that society has. More than ten years after this actual mission, it is important to have a system of indicators that help measure its efficiency, in order to know the situation of the State Public Universities (SPU) in Mexico in relation to this mission. Therefore, the objective of this research is to identify the degree of advancement of the dimensions of entrepreneurship, innovation and social commitment, by measuring technical efficiency. As a hypothesis, it proposed that the efficiency of the State Public Universities in Mexico with respect to its Third Stream is greater than 70%. Using the Data Envelopment Analysis (DEA) methodology, the following results show that the average technical efficiency with variable performance at scale is 91.30%, Being the innovation dimension the one that contains the largest number of universities with efficiency; while, the entrepreneurship dimension is the least efficient SPU. Therefore, the hypothesis that said institutions carry out activities aimed at promoting their Third Stream verified.

Keywords: data envelopment analysis, social commitment, efficiency, entrepreneurship, innovation.

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Resumo

A terceira missão das instituições de ensino superior visa gerar e aplicar conhecimentos que contribuam para a promoção do bem-estar social a nível regional, nacional e internacional. Para tal, as IES devem contribuir para a construção de projetos inovadores (científicos e tecnológicos) que permitam o desenvolvimento de metodologias disciplinares e multidisciplinares que facilitem a resolução de problemas reais que a sociedade apresenta. Mais de dez anos depois desta missão atual, é importante contar com um sistema de indicadores que ajude a medir sua eficiência para conhecer a situação das universidades públicas estaduais (UPE) no México em relação a essa missão. Portanto, o objetivo desta pesquisa é identificar o grau de avanço das dimensões empreendedorismo, inovação e compromisso social por meio da medição da eficiência técnica. Como hipótese, propõe-se que a eficiência das UPEs no México em relação à sua terceira missão seja superior a 70%. Utilizando a metodologia de análise envoltória de dados (DEA), foram obtidos os seguintes resultados: a eficiência técnica média com retornos variáveis de escala foi de 91,30%. A dimensão inovação foi a que obteve o maior número de universidades com eficiência, enquanto a dimensão empreendedorismo obteve a UPE menos eficiente. Isso significa que as instituições realizam atividades destinadas a promover sua terceira missão.

Palavras-chave: análise envoltória de dados, compromisso social, eficiência, empreendedorismo, inovação.

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Introduction

The third mission of higher education institutions (HEI) seeks to support social and economic development that is based on social responsibility and on their commitment to transform knowledge into economic value through key activities, such as generating applicable knowledge and promoting innovation, train professionals to advise R + D + i projects and participate in projects with entrepreneurs and in collaboration with the rest of economic agents (Vilalta, 2013).

Based on these activities, Bueno and Casani (2007) propose three directions to identify the lines of action that help to fulfill the third mission of the universities. The first is based on entrepreneurship as a creator of value, wealth and employment; the second, based

on the transfer of knowledge (innovation), and the last is the extension of its activities towards the economic and social development of its community (social commitment).

More than ten years after its foundation in HEIs worldwide, Bueno and Casani (2007) point out that it is important to measure and quantify the activities related to the third mission in order to know its progress and generate new strategies. However, they also state that each institution must have a system of indicators due to the characteristics of each university.

In this context, HEIs in Mexico must know the progress made by their third mission in order to identify both the efficient dimensions and those that require work.

Literature review

The third mission of the IES has its foundations in the development of strategies for "knowledge transfer to society, supported by innovation, social commitment and entrepreneurship; promoting the measurement and evaluation of performance on the generation, use, application and exploitation of knowledge with external actors and society "(Secundo, Pérez, Martinaitis and Leither, 2017, p. 229).

The activities that comprise this mission in European countries are entrepreneurship, innovation and social commitment, while in Latin America they consider it as an extension, that is, a way of spreading culture and sport (Calderón-Martínez, 2017; Ruiz, 2004) . However, for Marulanda and Rojas (2019), regardless of the country where the university is located, this mission incorporates various activities that are not taken into account within the first and second missions, that is, continuing education, public access to conferences and cultural assets, volunteer work and consulting, among others.

This variety of activities that make up the third mission has led to different methodologies and criteria to compare their development in different HEIs. Even so, there are associations of professionals in technology transfer that apply different systems of indicators to quantify and understand the situation of universities with respect to their third mission (Bueno and Casani, 2007).

In this sense, De la Torre (2016) mentions that a system of own indicators would help to describe, monitor, study and evaluate the activities of the third mission in universities. In this way, the organization of collaborators and objectives could be redefined, as well as knowing their capabilities, performance obtained, commitment to the region and probability of knowledge transfer.

For their part, Astigarraga and Eizagirre (2017) point out that the impulse of the third mission would contribute to economic and social development, which is why they suggest various conceptualizations and activities with different purposes. From the traditional point of view, they are considered activities related to the provision of services (commercialization of technology). This results in quantifying the economic results obtained through the transfer, the number of companies created based on the results of the research, contracts made with companies (for consultancies and joint projects) and patents obtained. That is, the results that allow the local and regional economy to be boosted are taken into account.

From the point of view of the university-company link, the indicators are aimed at measuring the quality and intensity of this relationship in order to create new university functions that allow it to be improved. In this sense, the incorporation of doctoral students and doctors who carry out direct research with companies is considered. However, Astigarraga and Eizagirre (2017) comment that "the relations between university and company are not only in productive aspects, but also include activities that help to understand and organize the interactions between knowledge and community life" (p. 76) .

Also, there are several sets of indicators for a single dimension. Authors such as Bensing, Caris-Verhallen, Dekker, Delnoij and Groenewegen (2003) and Piva and Rossi-Lamastra (2013) warn that having too many indicators makes their measurement difficult, since different objectives would be considered or would be oriented towards the development of the third mission in a very specific context. For this reason, and to ensure the homogenization of the indicators, there are three systems used in various European universities to try to know the progress that HEIs have made in relation to this mission.

> The first system is the Science and technology policy research at the universityt (SPRU project) by Molas-Gallart, Salter, Patel, Scott and Duran (2002). These authors designed a methodology that includes twelve categories to evaluate both activities and capacities. Another system is the Policies for research and innovation in the movey (PRIME) project of the Observatory of European University (OEU), created with the aim of developing studies focused on universities to carry out scientific benchmarking, patent analysis and relationships between universities. and industry (PRIME, 2006). Finally, there is the European indicators and ranking methodology for University Third Mission; Its purpose is to promote and improve the contribution to society by HEIs, improve the quality, efficiency and effectiveness of

educational systems in Europe, enhance excellence and improve the visibility of university activities aimed at serving society and the business sector (European Indicators and Ranking Methodology for University Third Mission [E3M], 2012).

These, of course, are not the only systems used to quantify the third mission in HEIs; however, they do not consider the dimension of social commitment because universities do not usually exhibit the results obtained or activities related to this dimension.

Despite the fact that these systems have already been used in different European and Latin American HEIs to know the situation they have with their third mission, it is necessary for Mexican universities to apply some of these, since they are committed to participating in economic development and of our country through the development of different projects.

Problem Statement

Traditionally, the evaluation of the efficiency of higher education has been carried out through the calculation of quality indicators, such as enrollment, graduation, school dropout, among others. However, this estimate has been increased in recent years due to accountability and the commitment to report on the use of resources granted by the treasury. As a consequence, different criteria have been established to measure the efficiency of HEIs. For example, the determination of efficiency through indicators related to the transfer of knowledge, the calculation of activities related exclusively to the first and second missions, and - to a lesser extent - the measurement of efficiency through actions of the three missions.

In any of the aforementioned criteria, inputs are used that are modified or used during the activity to generate an output, with the aim of providing information for decision-making (Cuenca, Li, Boza, Alarcón and Lario, 2008) . As a consequence of the efficiency measurement, in European countries public policies have been established for HEIs that have led to budget cuts, hiring of part-time staff and increased private financing. On the other hand, in our country, the Mexican government —through its different education sector programs— has established public policies that are aimed at ensuring the quality of higher education, reducing the difference and diversity of institutions that teach this type of education. education (evaluation and accreditation of educational programs, teacher training and improvement programs, and increased enrollment, among others) (Secretaría de Educación Pública [SEP], 2013).

However, the scarcity of empirical studies on this subject should be highlighted (Calderón-Martínez, 2017; Pedroza and Ortiz, 2013) due to the lack of public policies that contribute to knowing the progress that Mexican HEIs have had in relation to the activities of the third mission and because there is no appropriate system of indicators on the characteristics of these universities, which would help to know the degree of efficiency and, above all, if the institutions wish to meet the new challenges posed in around higher education worldwide.

Having explained the above, in this study the following research question has been formulated: what is the degree of progress of the third mission, measured in terms of technical efficiency, of the Mexican State Public Universities (UPE)?

Justification

This research tries to contribute to the assessment of the third mission of the UPE in Mexico. The reason for this purpose is that the aforementioned institutions must know the results of the activities developed around that mission, which would serve to make decisions that would contribute to the economic and social development of the surrounding region.

In addition, a system of indicators is proposed that adapts to our Mexican reality based on the SPRU project, since - according to De la Torre (2016) - said system is oriented to the activities themselves, and not to the results or the impact they have had on society. In addition to this system of indicators, for the dimension of social commitment, the institutional policy focused on attending to the social needs and expectations of the National Association of Universities and Institutions of Higher Education (Anuies) (2016) is considered as a form of adapt the tasks of this dimension to what the UPEs are currently doing.

Therefore, this research presents an analysis of the technical efficiency of UPE from the methodological perspective of data envelopment analysis (DEA, for its acronym in English).

Overall objective

Identify the degree of progress of the activities of the third mission in the UPE in order to contribute to the improvement of the quality and competitiveness of higher education in Mexico through an analysis of technical efficiency.

Hypothesis

To meet the objective set out in this work, the following hypothesis is developed:

- The efficiency of state public universities in Mexico with respect to their third mission is greater than 70%.

Methodology

This research is based on a non-experimental cross-sectional design with a descriptive and comparative scope.

Proposal and selection of the units of analysis and indicators

The SEP classifies HEIs in various training preferences based on the interests and professional goals that students want to achieve. The Public Higher Education System (SESP) is made up of seven subsystems, of which the UPEs are the ones with the highest number of students, teachers and research professors who belong to the National System of Researchers (SNI); In addition, it ranks second in terms of financing granted by the State. In addition to this, 100% of these institutions are affiliated with the National Association of Universities and Institutions of Higher Education (Anuies), and to a lesser extent the Consortium of Mexican Universities (CUMex), organizations whose objective is quality assurance in educational programs and the development of teaching, research and extension functions. Therefore, the units of analysis for this work are the 34 UPE that make up this group of IES.

Efficiency concept and its measurement

According to Rodríguez (2009), efficiency is "taking advantage of all possible opportunities to improve the situation of some people without making the situation of others worse" (p. 44). According to Farrell (1957), decision making units (DMUs) are made up of two elements: technical efficiency (TE), which is when the company obtains the maximum output with the combination of inputs used (Cachanosky, 2012), and the allocative efficiency (AE) or the ability of producers to combine inputs and outputs in the best way, considering prices and marginal products (Vázquez-Rojas, 2011). This analysis focuses on technical efficiency because it shows whether the resources of the UPEs are exploited to the maximum of their productive capacity.

Technical efficiency can be assessed through the orientation of inputs or outputs. The orientation to inputs (ET1), minimizes the use of these for a given level of outputs. And with an output orientation (ETo), it maximizes the outputs for a given level of inputs (Vázquez-Rojas, 2011). Due to the minimum degree of control that the UPEs have in relation to their inputs, it is convenient to try to maximize the outputs, without trying to reduce the inputs available to each university. Therefore, the orientation to output is considered as a way of evaluating the efficiency of the UPE in relation to the activities of the third mission.

For his part, Álvarez (2013) points out that the frontier function is the production limit, and is considered as the reference point to calculate inefficiency. This frontier is composed of production, cost and benefit functions. As for the production frontiers, they are divided based on the technique used for their construction, which can be by means of parametric and non-parametric techniques. For Rodríguez (2009) the advantage of the latter is that the measurement of efficiency is carried out by comparing each DMU, through a linear combination that allows obtaining indicators for each of the units, such as the DEA.

Measurement of efficiency in higher education through the DEA

The DEA technique was created by Charnes, Cooper and Rhodes (1978) as a methodological tool for calculating the technical efficiency of DMUs by means of a mathematical optimization program. The criterion used by this technique to identify the production frontier as an envelope to the data that considers all those efficient units and the set of hypothetical units built from these, applying the convexity assumption. The resulting frontier is considered feasible and efficient, with the rest of the units (inefficient) being below it. Likewise, the efficiency measure obtained by this technique is relative, since each unit is compared with those that operate with a similar value of inputs and outputs in order to diagnose their situation in the envelope (efficient) or to distinguish their reference units in order to change inefficiencies for efficiencies (Vázquez-Rojas, 2011).

Efficiency, for the DEA, is the result of the ratio of a single output over a single input; if the result is 1, the DMU is said to be efficient, while those that get <1 are considered inefficient. Consequently, it is possible to compare which units of analysis are "better" and with which one must work to be so.

In the education sector, the DEA has been used to analyze its efficiency. Authors such as Becerril-Torres, Álvarez-Ayuso and Nava-Rogel (2012), Martí, Puertas and Calafat (2014), De Witte and López-Torres (2015), De la Torre (2016) and Villarreal and Tohmé (2017), Among others, they have applied it in different HEIs around the world to estimate the production frontier based on a series of indicators.

To apply the DEA in this analysis, it is necessary to select one of the two basic models used: the first is the Constant Performance Scale (CCR) model —proposed by Charnes et al. (1978) -, which assumes a constant scale performance and provides proportional efficiency measures without considering organizational implications, such as the size of the institutions or the level of production. And the Model of Returns to Scale (BCC) - created by Banker, Charnes and Cooper (1984) - assumes variable returns to scale. Its objective is to evaluate technical efficiency by removing the influence of economies of scale in evaluating the efficiency of DMUs. That is, this model considers the possibility of inefficiencies derived from the differences between the operating scales in each DMU (Fuentes-Pascual, 2011).

Regarding the selection of the basic model of the DEA, according to Avkiran (2001), for the selection of the type of performance that is desired to be used in an investigation, technical efficiency should be measured by applying the CCR and the BCC models with the purpose to know if there are differences between them. In the case that results were obtained with different efficient DMUs, the BCC model is applied; If no difference is found between the results, the CCR model is used. To calculate technical efficiency, DEAP 2.1 software is used (Coelli, 1996). Once applied, it is obtained that for the CCR model there are ten UPE with scores lower than 1.0, while in the BCC model, nine UPE presented inefficiency. Therefore, although it is a very small difference, the BCC model is chosen.

Selection of inputs and outputs

For this research, the activities of the first and second mission (enrollment, full-time professors-researcher and subsidy in education) are estimated as inputs. Table 1 presents these indicators with their definitions.

Tabla 1. Selección de *inputs* y sus definiciones

Inputs	**Definición**
Matrícula	Conjunto de alumnos inscritos durante un ciclo escolar en una institución o plantel educativo (SEP, 2008).
Profesores de tiempo completo (investigador)	Término que abarca a todas las personas (investigadores, analistas y auxiliares o asistentes de investigación) que participan en las tareas propias de un proyecto de investigación, es decir, en las actividades teóricas, metodológicas y prácticas (SEP, 2008).
Subsidio en educación	Asignación que otorga el gobierno federal o el estatal a las IES para el cumplimiento de los fines de estas (SEP, 2008).

Fuente: Elaboración propia

On the other hand, the outputs are divided into the three dimensions that make up the third mission. The following tables show the products used by each one of them; that is, in table 2 outputs for entrepreneurship activities; in table 3 outputs that are considered for the innovation dimension; finally, in table 4 outputs for the social commitment dimension.

Tabla 2. *Outputs* empleados para la dimensión *emprendimiento*

Dimensión	*Output*	Definición
Emprendimiento	Patentes concedidas Patentes solicitadas	Derecho exclusivo que se concede sobre una invención. En términos generales, una patente faculta a su titular a decidir si la invención puede ser utilizada por terceros y, en ese caso, de qué forma. Como contrapartida de ese derecho, en el documento de patente publicado, el titular de la patente pone a disposición del público la información técnica relativa a la invención (OMPI, 2018).
	Empresa incubada	Empresas que son apoyadas por las IES a los nuevos emprendedores, asesorando y prestando la infraestructura para disminuir riesgos de costos de marcha y el proceso natural de aprendizaje (Wompner, 2007).
	Marcas	Todo signo susceptible de representación gráfica, capaz de distinguir en el mercado; productos, servicios o establecimiento comerciales o industriales (INAPI, s. f.)
	Diseño industriales	Derecho exclusivo de explotación concedido por el Estado, a través del Instituto Mexicano de la Propiedad Industrial a la persona que realiza un diseño industrial y/o al titular de este; es decir, al inventor/diseñador o titular del mismo (INAPI, 2018).
	Derecho de autor	Reconocimiento que otorga el Estado a todo creador de obras literarias y artísticas, en virtud del cual el autor goza de derechos de tipo personal, llamado *derecho moral*, y económico llamado *derecho patrimonial* (INDAUTOR, s. f).
	Modelo de utilidad	Títulos de propiedad industrial que, al igual que las patentes, protegen invenciones, pero de escaso valor creativo o de innovación no radical (INAPI, s. f.).
	Empleados de empresas incubadas	Persona que generalmente precisa de cierta cualificación que realiza una actividad laboral por cuenta de un particular, una empresa incubada o el Estado y por la que recibe una contraprestación económica (Economía48, s. f.).
	Fondo para empresas incubadas	Es un fondo que tiene como objeto incentivar el crecimiento económico nacional, regional y sectorial, mediante el fomento a la productividad e innovación (INADEM, 2018).
	Asesorías	Servicio profesional que orienta al directivo de una organización. Es una guía de expertos que responde dudas específicas, resuelve problemas concretos y apoya a las organizaciones en los trámites necesarios para su operación (CENAPYME, 2019a).
	Consultoría	Servicio profesional especializado que puede ayudar a la dirección general de las organizaciones a enfrentar situaciones que impiden la operación plena del negocio (CENAPYME, 2019b).

	Usuarios que hicieron uso de las instalaciones	Insumos requeridos para llevar acabo los procesos que tienen lugar en las instituciones escolares, lo que a su vez impacta en los productos del sistema educativo (INEE, 2007).
	Eventos culturales	Son eventos organizados y coordinados por la Unidad Académica Extra programáticas y buscan, a través de la puesta en escena de una variedad gama de manifestaciones artísticas, esparcimiento y la recreación cultural de los estudiantes, la comunidad universitaria y público en general (Universidad de Concepción, s. f.)
	Eventos artísticos	Son actividades de formación, difusión, artísticas, lúdicas y recreativas (IMEP, 2018)
	Proyectos con financiamiento externo y Número de proyectos financiados por Conacyt o por estancias externas	Procedimiento científico que tiene como objetivo buscar información y formular hipótesis sobre un fenómeno social o científico (Tamayo, 1999).

Fuente: Elaboración propia

Tabla 3. *Outputs* empleados para la dimensión *innovación*

Dimensión	*Output*	Definición
Innovación	Artículos publicados en ISI	Es un medio por el cual se difunde la generación de conocimiento; se logra mediante la investigación de los investigadores en las IES (Miyahira, 2017).
	Artículos publicados en SCOPUS	
	Número de organizaciones que participan en proyectos de investigación	Propuesta de investigación en la que se describen la fase de planificación (conceptual y de diseño) de la investigación que se va a iniciar (Icart, Fuente Isaz y Pulpón, 2001).
	Alumnos que participan en estancias de investigación saliente	Desplazamiento de estudiantes, docentes, investigadores o administrativos hacia otra institución para realizar semestres académicos, pasantías y prácticas, investigaciones, o para asistir o participar en programas de educación continua (Universidad de San Buenaventura, 2018).
	Movilidad académica saliente	
	Cursos de educación continua (sin considerar cursos de idiomas)	Programas de formación y actualización (presenciales o en línea) enfocados a mejorar e impulsar el camino profesional y experiencia de vida, de manera práctica, competitiva y socialmente responsable (UNID, 2019).
	Posgrados que pertenecen al PNPC Número de alumnos que cursan un posgrado que pertenece al PNPC	El Programa Nacional de Posgrados de Calidad (PNPC) forma parte de la política pública de fomento a la calidad del posgrado nacional que el Conacyt y la Subsecretaría de Educación Pública han impulsado de manera ininterrumpidamente desde 1991 (Conacyt, 2019).
	Egresados en búsqueda de empleo	Recién egresado de una IES que busca conseguir un empleo dentro de su área de formación durante los primeros 6 meses de haber concluido sus estudios (Domínguez, Silva, Castorena, Barrera y Ramírez, 2017).
	Satisfacción de egresados	Encuesta que permite conocer la opinión en términos de satisfacción de los egresados acerca de diferentes aspectos (UCAM, 2015)
	Convenios de colaboración en el último año	Vínculos de colaboración con empresas y organismos públicos o privados relacionados al sector productivo, con el objetivo de transferir tecnologías desarrolladas en las IES y, formar alianzas estratégicas con empresas por medio de proyectos de I+D+i, a fin de apoyar su desarrollo económico y competitivo (UAM, 2019).

Fuente: Elaboración propia

Tabla 4. *Outputs* empleados para la dimensión *compromiso social*

Dimensión	*Output*	Definición
Compromiso social	Conferencias (académicas y no académicas)	Discurso normalmente expositivo, aunque también puede tener elementos argumentativos, de carácter formal, que se caracteriza por ser una sola intervención durante un tiempo amplio y ante un público numeroso. Dependiendo del público al que están orientadas, pueden ser de tipo divulgativo o especializado (Briz, Abelda, Fernández, Hidalgo, Pinilla y Pons, 2008).
	Notas periodísticas	Información que tenga que ver con un acontecimiento actual y que generalmente es escrita y transmitida a través de algún medio de comunicación en periódicos (Características Org, 2014).
	Medio ambiente	El medio ambiente es el compendio de valores naturales, sociales y culturales existentes en un lugar y un momento determinado, que influyen en la vida material y en el futuro de generaciones venideras (Ambientales, R.D.A y SEEDA., 2001).
	Personal académico inducido a la responsabilidad social	Responsabilidad social se considera como un principio rector y a la vez transversal a todas las funciones sustantivas, buscando construir una nueva etapa de desarrollo de la educación superior, cuyos ejes sean garantizar la inclusión de los jóvenes en los procesos de formación avanzada, así como la consecución de niveles superiores de calidad y responsabilidad de los actores participantes en los procesos de transmisión, generación y divulgación del conocimiento (Castañares y Cruz, 2012, p. 23).
	Proyectos sociales que atiendan a la comunidad vulnerable	Los proyectos sociales son una herramienta que permite inducir un cambio a partir de las iniciativas de los actores que interactúan en un territorio o sector específico (Baca-Tavira y Herrera-Tapia, 2016, p. 208).
	Personas beneficiadas por servicios a la comunidad local Servicios para la comunidad local	Las comunidades locales varían en tamaños, composición, estructura y organización. Una comunidad local incluye a la autoridad gubernamental local, así como a otras empresas locales, escuelas y actividades culturales (Carta de la tierra, s. f.).

Fuente: Elaboración propia

Determination of frequency

To obtain the information on the selected indicators, a documentary review of institutional development plans, rectorial reports, statistical yearbooks and the EXECUM database (UNAM, 2017) was carried out, of which results were only found for the 31 Universities that provided the information on the indicators proposed in this research (that is, there was 91.17% participation).

By their number of students, institutions are classified into mega, large and small (Galaz, 1998). Derived from this classification, it is considered pertinent to calculate the frequency of the activities carried out by these institutions in order to have those that carry out the same number of activities, regardless of their size. Table 5 shows the result of the frequency calculation (relative and cumulative). Once calculated, only the UPEs that perform between 18 and 26 tasks are considered, because in this range there is a greater number of universities; in this way the majority is included and their efficiency is determined in relation to the third mission.

Tabla 5. Cálculo de frecuencia

Rangos	f1	F1	h1	H1
0	0	0	0	0
3	0	0	0	0
6	0	0	0	0
9	0	0	0	0
12	3	3	0.967742	0.096742
15	3	6	0.0967742	0.1935484
18	4	10	0.1290323	0.3225806
21	11	21	0.3548387	0.6774194
24	7	28	0.2258065	0.09032258
27	3	31	0.0967742	1.00
Total	**31**		**1.00**	

Fuente: Elaboración propia

The 23 UPEs that are in this range are the following: University of Guadalajara, University of Guanajuato, University of Sonora, Veracruzana University, Benemérita Autonomous University of Puebla, Autonomous University of Baja California, Autonomous University of Nuevo León, Autonomous University of Sinaloa ; Universidad Autónoma de Chihuahua, Universidad Autónoma de Tamaulipas, Universidad Autónoma de Querétaro, Universidad Autónoma de Chiapas, Universidad Autónoma de San Luis Potosí, Universidad

Autónoma de Zacatecas, Universidad Autónoma de Aguascalientes, Universidad Autónoma de Baja California Sur and Universidad Autónoma de Campeche, Universidad Autonomous University of Yucatán and Autonomous University of Ciudad Juárez, Autonomous University of the State of Hidalgo and Autonomous University of the State of Morelos, Autonomous University of Tabasco Juárez and Technological Institute of Sonora.

Results

Derived from obtaining results on the technical efficiency of each UPE, in the sense of variable returns to scale, it is observed that 21 universities have best practices, that is, 91.30% of the institutions are within the production frontier, by obtaining a score of 1.0 in its scaling efficiency (table 6).

Tabla 6. Eficiencia técnica sentido BCC

UPE	VRSTE	Escala
UDG	1.00	1.00
UABC	1.00	1.00
UANL	1.00	1.00
UV	1.00	1.00
BUAP	1.00	1.00
UACH	1.00	1.00
UAEH	1.00	1.00
UAEM	1.00	1.00
UJAT	1.00	1.00
UAQ	1.00	1.00
UACJ	1.00	1.00
UGTO	1.00	1.00
UNISON	1.00	1.00
UNACH	1.00	1.00
UASLP	1.00	1.00
UAZ	1.00	1.00
ITSON	1.00	1.00
UAA	1.00	1.00
UADY	1.00	1.00
UABS	1.00	1.00
UACAM	1.00	1.00

Fuente: DEAP 2.1 Coelli (1996) y elaboración propia

To identify if the inefficiency of the DMUs is due to the fact that they are operating under diminishing returns to scale (DRS) —that is, when the amount of inputs used is modified and as a consequence the quantity of outputs decreases— or by increasing returns to scale (IRS, for its acronym in English Increasing Return to Scale) —that is, when the quantity used in the inputs is modified, then the quantity of outputs increases. Table 7 shows the Autonomous University of Sinaloa, which is in the segment of diminishing returns to scale (DRS), which means that when its inputs increase, its outputs do not increase in the same proportion.

Tabla 7. UPE con rendimiento decreciente de escala (DRS)

UPE	VRSTE	Escala
UAS	0.948	0.948

Fuente: Elaboración propia

Table 8 shows the Autonomous University of Tamaulipas (UAT), which is in the segment of increasing returns to scale (IRS); As a consequence, by increasing its inputs, the increase in its outputs will be greater than the additional proportion.

Tabla 8. UPE con rendimiento creciente de escala (IRS)

UPE	VRSTE	Escala
UAT	0.524	0.997

Fuente: Elaboración propia.

In these first results, efficient UPEs are taught in relation to the activities of the third mission. However, to respond to the proposed objective, the DEA is applied again, but by separate dimensions in order to reaffirm its leadership or identify the dimension that should work more on it to promote the development of said mission.

Entrepreneurship dimension

To measure the efficiency of the UPE under the dimension of entrepreneurship, the same number of inputs is considered; However, for the outputs, only eight variables are considered, which are patents (applied for and granted), trademarks, industrial designs and utility models, incubated companies and number of employees in incubated companies, fund for incubated companies, number of users that They used the facilities and attended cultural events. Table 9 shows the efficient UPE in entrepreneurship with a VRS sense oriented towards output.

Tabla 9. UPE eficientes en la dimensión de emprendimiento

UPE	VRSTE	Escala
UDG	1.00	1.00
UABC	1.00	1.00
UACJ	1.00	1.00
UGTO	1.00	1.00
UNISON	1.00	1.00
UASLP	1.00	1.00
ITSON	1.00	1.00
UAA	1.00	1.00
UADY	1.00	1.00

Fuente: Elaboración propia

As can be seen, when considering only the entrepreneurship outputs, only nine UPEs continue to be efficient, that is, 60.87% of all universities are considered inefficient.

In relation to the UPEs that are below the production frontier with decreasing returns to scale (DRS), there are three universities that when increasing their inputs, their production will not increase in the same proportion. Table 10 shows these HEIs with their scale efficiency score obtained for the entrepreneurship dimension.

Tabla 10. UPE con DRS en la dimensión de emprendimiento

UPE	VRSTE	Escala
UANL	0.879	0.879
UV	0.397	0592
BUAP	0.853	0.853

Fuente: Elaboración propia

As for the UPE that present inefficiency with increasing returns to scale, they represent 47.83% of the total number of universities. Table 11 shows these institutions.

Tabla 11. UPE con IRS para la dimensión de emprendimiento

UPE	VRSTE	Escala
UACH	0.945	0.961
UAEH	0.323	0.622
UJAT	0.502	0.810
UAT	0.209	0.744
UAQ	0.617	0.777
UNACH	0.631	0.732
UAZ	0.312	0.652
UABS	0.547	0.547
UACAM	0.782	0.782

Fuente: Elaboración propia

Innovation dimension

For this dimension, the outputs that help to measure efficiency are the amount of projects financed by Conacyt, number of research projects, published articles (ISI and SCOPUS), number of organizations participating in research projects, outgoing research stay (teachers and students), teachers in outgoing mobility, continuing education courses, number of graduate degrees belonging to the PNPC, students enrolled in graduate programs belonging to the PNPC and number of signed agreements. As can be seen, this dimension is made up of fourteen outputs, that is, it is the dimension of the third mission that has the most production. When applying the DEA in this category, it is obtained that fourteen UPE are efficient in terms of innovation, and only 39.13% are inefficient. In table 12 efficient universities can be visualized.

Tabla 12. UPE eficientes para la dimensión de innovación

UPE	VRSTE	Escala
UDG	1.00	1.00
UABC	1.00	1.00
UV	1.00	1.00
UACH	1.00	1.00
UAEH	1.00	1.00
UAEM	1.00	1.00
UAQ	1.00	1.00
UACJ	1.00	1.00
UASLP	1.00	1.00
UAZ	1.00	1.00
ITSON	1.00	1.00
UAA	1.00	1.00
UABS	1.00	1.00
UACAM	1.00	1.00

Fuente: Elaboración propia

The SPUs that are inefficient in terms of diminishing returns to scale for the innovation dimension represent 17.39% of the twenty-three institutions that participate in this analysis. Table 13 shows the UPEs with their obtained score.

Tabla 13. UPE con DRS en la dimensión de innovación

UPE	VRSTE	Escala
UANL	0.820	0.820
BUAP	0.549	0.549
UNACH	0.872	0.998
UADY	0.917	0.921

Fuente: Elaboración propia

The inefficiency in terms of increasing returns to scale in the innovation dimension are five SPUs that obtained scores <1.00 for being below the production frontier. Table 14 shows the universities with their respective values.

Tabla 14. UPE con IRS para la dimensión de innovación

UPE	VRSTE	Escala
UAS	0.496	0.952
UJAT	0.626	0.974
UAT	0.390	0.959
UGTO	0.800	0.989
UNISON	0.655	0.935

Fuente: Elaboración propia

Social commitment dimension

In this stage of the efficiency measurement, considering only the variables of social commitment as outputs, the following were found: number of agreements in the last year, number of conferences given, number of radio and television programs, number of programs radio, activities related to the environment, personnel trained in social responsibility, number of projects for vulnerable communities, number of people benefited in vulnerable situations and number of services to serve the vulnerable community.

Regarding the results for this dimension, 12 UPE are on the production frontier, that is, they are efficient universities. This means that only 52.17% of them are within this group with better performance in their social commitment. Table 15 shows the UPE that show a better performance in social commitment.

Tabla 15. UPE eficientes en la dimensión de compromiso social

UPE	VRSTE	Escala
UANL	1.00	1.00
UV	1.00	1.00
UACH	1.00	1.00
UAEH	1.00	1.00
UAEM	1.00	1.00
UNISON	1.00	1.00
UNACH	1.00	1.00
UASLP	1.00	1.00
ITSON	1.00	1.00
UADY	1.00	1.00
UABS	1.00	1.00
UACAM	1.00	1.00

Fuente: Elaboración propia

In this scenario, three UPEs are observed that are inefficient in terms of decreasing returns to scale, which means 13.04% of all universities. Table 16 shows this result.

Tabla 16. UPE con DRS en la dimensión de compromiso social

UPEs	VRSTE	Escala
UAS	0.746	0.746
UJAT	0.544	0.544
UAZ	0.564	0.996

Fuente: Elaboración propia

Finally, there are eight efficient UPEs with increasing returns to scale for the social commitment dimension. In table 17 you can see which are the universities and their results.

Tabla 17. UPE con IRS para la dimensión de innovación

UPE	VRSTE	Escala
UDG	0.003	0.065
UABC	0.307	0.894
BUAP	0.122	0.859
UAT	0.114	0.576
UAQ	0.460	0.736
UACJ	0.065	0.178
UGTO	0.662	0.996
UAA	0.629	0.789

Fuente: Elaboración propia

Discussion

The third mission in HEIs helps universities to have a more active participation with society through activities that motivate research, development and technological and social innovation. At the same time, this mission promotes the fulfillment of their "social function", which enables a greater involvement in the social and cultural life of the region or country where they are located.

In this sense, the European Union recognizes the new role that universities have, and as a consequence has established different proposals that contribute to the progress of its third mission, such as increasing investment in science and technology in relation to gross domestic product, the closest link with companies, the improvement of knowledge transfer (oriented towards entrepreneurship, innovation and social cooperation) and the evaluation of results (CE, 2003).

In our country, universities have incorporated activities related to the third mission as a way to meet the challenges of higher education worldwide. However, unlike European universities, there is a lack of a system of indicators adapted to their characteristics that helps to know the progress they have made in achieving this goal.

In this scenario, documentary-type studies have been carried out in our country, and the main results show that the entrepreneurship dimension is the one that presents the greatest progress in activities such as patents (applied for and granted) and number of incubated companies (Pedroza and Ortiz, 2013), data that coincide with that reported by Calderón-Martínez (2017). Even so, the aforementioned authors emphasize that the lack of information makes it difficult to measure this mission.

For this reason, it is worth noting that this research constitutes one of the first studies about the third mission in a group of Mexican HEIs, for which the largest number of indicators have been used, which try to include all the activities of the three dimensions that make up this mission.

Therefore, it is not possible to make a comparison of the results obtained, since in this research the SPRU Project indicators (Molas-Gallart et al., 2002) were adapted and they were also added for the dimension of social commitment based on recommendations made by Anuies (2016). Furthermore, the same methodology was not used to measure efficiency. Even so, this research manages to quantify the progress made by the UPEs with respect to the development of their third mission. Furthermore, with the results obtained, it is recognized which dimension has been with the greatest progress and the dimension that needs the most attention is distinguished.

Finally, based on this proposal, there is the possibility that the suggested system could be complemented with other types of activities in subsequent studies that contribute to the fulfillment of its third mission not only for this type of university, but for any HEI in Mexico.

Conclusions

Through the non-parametric technique of data envelopment analysis, the technical efficiency of state public universities in relation to their third mission can be measured. The results obtained allow determining that the average technical efficiency with increasing returns to scale is 0.997 in relation to the activities of its third mission, which means that only two universities are below the production frontier.

Based on these results, the dimensions that make up said mission are evaluated. In this sense, it was determined that the average technical efficiency in the innovation dimension is 96.10%, in entrepreneurship 85.30%, and in social commitment 84.30%. Regarding the number of efficient UPEs, again innovation is the highest dimension with fourteen universities, followed by social commitment with twelve and entrepreneurship with nine. The Autonomous University of San Luis Potosí and the Technological Institute of Sonora are the universities that in each one of the dimensions remained within the production frontier.

Likewise, the UPEs that are in the segment of diminishing returns to scale were identified, which means that when they increase their inputs, their production will not increase in the same proportion. Likewise, they are presented to universities with increasing

returns to scale, which by increasing their inputs will obtain a greater increase in their production. In this segment, several institutions are located; however, the Autonomous University of Tamaulipas and the Autonomous University of Sinaloa have this behavior in all three dimensions.

With the present investigation it has been possible to recognize that the UPE in Mexico have incorporated activities related to their third mission into their daily work, which serves to affirm that the proposed hypothesis is valid.

Finally, it is observed that the UPEs in Mexico are promoting the activities included in the third mission. However, there is still a lack of public policies that promote the development of this mission so that efficiency is favored in each of the dimensions. In this way, there will be a greater rapprochement between these universities and society, which will stimulate the technological and social development of our country.

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Conceptualización	Maribel (principal) Angélica (igual)
Metodología	Maribel (principal) Angélica (igual)
Software	Maribel
Validación	Angélica (principal) Maribel (igual)
Análisis Formal	Maribel (principal) Angélica (igual)
Investigación	Maribel (principal) Angélica (igual)
Recursos	Maribel (principal)
Curación de datos	Maribel (principal) Angélica (igual
Escritura-preparación del borrador original	Maribel
Escritura-revisión y edición	Angélica
Visualización	Maribel (principal) Angélica (igual)
Supervisión	Angélica
Administración de proyectos	Maribel
Adquisición de fondos	Maribel (principal) Angélica (igual)